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Dielectric properties of sodium benzoyl acetonate

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The effect of temperature on the dielectric constant and loss tan δ of sodium benzoyl acetonate were studied. The dielectric constant and dielectric loss were found to attain maximum values at about 75°C. This may be due to change of chemical composition of the material at that temperature which caused flow of charges towards the sample surfaces

1 INTRODUCTION

The electrical behaviour of some metal organic compounds were previously studied (Tawfik 1974, Swaby 1973, Abdel-Aty 1976) It was found that sodium acetyl acetonate only showed anomalous behaviour A peak value of dielectric constant and loss were noticed at the transition temperature 82°C The dielectric behaviour of the ferroelectric materials showed a pronounced increase of the dielectric constant at a critical temperature This is due to transition of crystal structure from tetragonal to cubic system as previously investigated (Ouchi 1965, Tawfik 1974, Shigeru 1964, Krasnikova 1976).

The purpose of this investigations was to study the dielectric behaviour of sod ben. acet At the present now the crystal structure of this material is not known. It is needed to increase our knowledge about the crystal structure before and after the transition temperature of the material.

2. EXPERIMENTAL PROCEDURE

Sodium benzoyl acetonate was prepared from the reaction of sodium ethoxide and acetophenone. The powder was pressed into tablets at 1000 kg/cm^2, having diameter 12 mm and thickness 1 mm. Two silvered electrodes were applied on the faces of the tablet

The dielectric constant and loss were measured at different temperatures using bridge type B 801

3 RESULTS AND DISCUSSION

Effect of temperature on ϵ and tan δ of Sodium benzoyl acetonate.

The dielectric constant (ϵ) and loss (tan δ) of sodium benzoyl acetonate sample were measured as a functions of temperature At room temperatures,

it was noticed trat the values of E for these compounds were generally small of about 16 An anomalous change with temperature is shown in figure (1) It can be shown from the figure that ϵ of sod ac. ac. compound is nearly constant in the temperature ranging from room temperature to about 40°C Above this temperature the dielectric constant began to increase attaining maximum value at about 75°C The dielectric loss (tan δ) showed also a maximum at about this temperature as shown in figure 1 Above this temperature the dielectric constant and loss decreased with increasing the temperature approaching the initial values again at about 110°C It was also noticed that the value of ϵ and tan δ were strictly reproducible at all temperature below 75°C. Above 75°C, the reproducibility of ϵ and tan δ was greatly impaired and the ϵ and tan δ peaks disappeared completely when the observation run started from high temperature to lower temperature as indicated by the two arrows in figure 1 This behaviour was attributed to the possible existence of an irreversible change in the structure

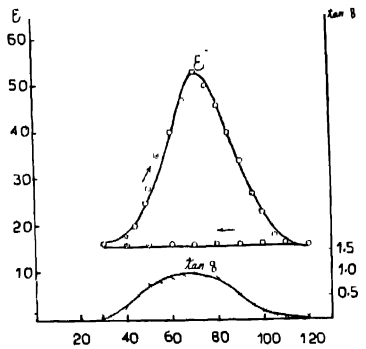

Fig 1

of sod. bz ac The existence of a transition temperature for a ferroelectric material was attributed to some transition process For instance in the case of $BaTiO_3$ a transition from the tetragonal to the cubic crystal structure takes place at about 120°C at which maximum dielectric constant was occurred. In the present work, the sod ben ac. compound gave a peak value of the dielectric constant and loss at 75°C were attributed to the intermolecular change The substance has undergone permanent chemical transformation at that temperature (as indicated from chemical analysis) This chemical transformation accompanied by change of crystal structure from monoclinic to triclinic (as calculated from X-ray diffraction patterns) caused generation of an internal electric charges during heating. The charges were able to move resulting in higher capacity.

During cooling the new composition did not return to its initial chemical structure causing the irreversible change with temperature.

X-Ray diffraction of sodium benzoyl acetonate

Philips X-ray diffractometer was used in the present test for recording the diffraction patterns. The working condition of the instrument was maintained constant throughout the whole test. The patterns were seen using filtered Co radiation at 30 KV and 10 ma. The scanning speed was 2°/min in the range from $2\theta = 4°$ to $2\theta = 68°$. Figure 2 shows the X-ray diffraction pattern for the sod. ben. ac. compound before heating. Figure 3 for sod. ben. ac. heated to a temperature of 90°C for one hour, then cooled to room temperature. It is seen that the two diffraction patterns were not similar.

From the study of dielectric properties it was found that sod. ben. ac. has anomalous behaviour at 75°C. Therefore, it was very interesting to study this

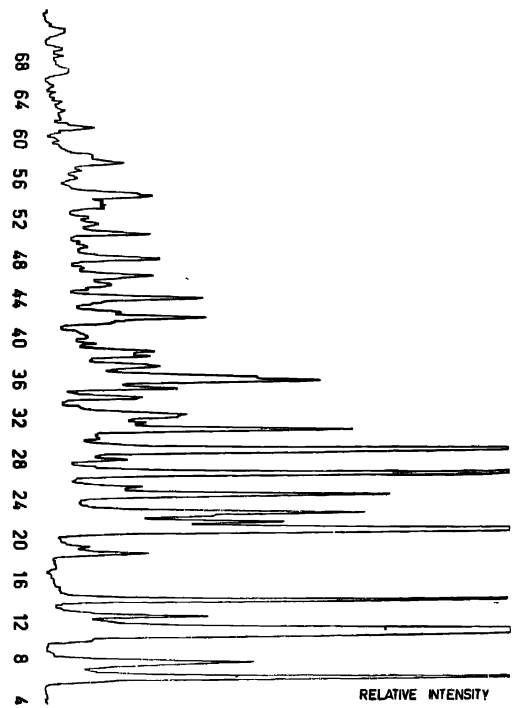

Fig. 2.

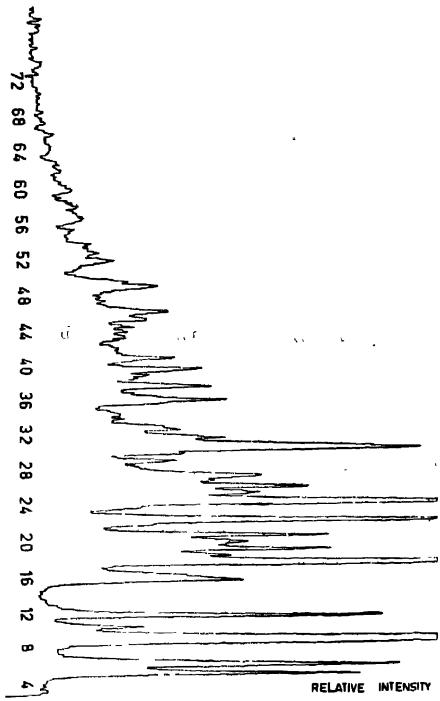

Fig. 3.

change by X-ray method. On the other hand, it was noticed trat this substance has not been examined by X-ray till now neither in X-ray cards nor in literature.

The X-ray diffraction patterns of sod. ben. ac was studied before and after the transition temperature. The studied were dependent on the indexing of cell dimension of the lattice for conditions.

(a) *Unheated sod. ben. ac.*

The interplaner spacings and corresponding $Q\,(Q = 1/d^2)$ values were calculated from the table. Therefore the dimensions of the reciprocal cell then become

$$a^2 = \cdot 0035 \qquad b^2 = \cdot 005 \qquad c^2 = \cdot 0089.$$

The direct cell dimensions resulting from the calculations

$a = 13{\cdot}334$Å $= 90°$
$b = 9{\cdot}3179$Å $= 125°58'$
$c = 8{\cdot}37$Å $= 90°$

Therefore, the unheated sod. ben. ac. belongs to monoclinic system $a, b, c = 90°, 125°58', 90°$.

(b) *Sod. ben ac. heated to* 90°C (*new substance*)

The dimension of the reciprocal cell

$a^2 = 0{\cdot}0037$
$b^2 = 0{\cdot}0052$
$c^2 = 0{\cdot}011.$

The direct cell dimensions resulting from the calculation.

$a = 21{\cdot}0985$Å $= 87°28'$
$b = 17{\cdot}239$Å $= 104°29'$
$c = 9{\cdot}935$Å $= 125°46'$.

Therefore, the crystal system of the new substance belongs to the triclinic system.

The method of the calculation to determine the crystal structure of sod. ben ac. is similar to previous investigation on sodium acetyl acetonate (Swaby 1973).

X-Ray diffraction pattern data

No,	The sample before heating	After heating to 90°C
	d°A	d°A
1	12·95	16·45
2	12·98	13·81
3	10·27	9·50
4	9·26	8·425
5	8·29	7·39
6	7·25	6·93
7	5·63	5·91
8	5·34	5·59
9	4·89	5·41
10	4·73	4·93
11	4·53	4·77
12	4·20	4·57
13	4·10	4·48
14	3·88	4 41
15	3·70	4·23
16	3·56	4·06
17	3·46	3·895
18	3·35	3·72
19	3 29	3·895
20	3·23	3·72
21	3·20	3·59
22	3·50	3·46
23	2·97	3·44
24	2·90	3·42
25	2·88	3·39
26	2·80	3·30
27	2·73	3·25
28	2·69	3·22
29	2·65	3·16
30	2·60	3·14

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